Integral Modulating Anode Resistor

R. H. Smith
R.F. Systems Development Section

The klystron in the Deep Space Network 400-kW transmitter subsystem uses a resistor to hold the modulating anode at ground potential. The resistor is connected to the klystron modulating anode through a high-voltage connector; in the past this resistor has been mounted in an air dielectric environment and has been subject to physical damage. If a cathode arc occurs, the arc forms between the cathode and modulating anode, the modulating anode potential is biased to the potential of the cathode by the arc current in the modulating anode resistor, and the arc is extinguished. The modulating anode resistor will have high-voltage (65 kV) across it during an arc.

This article describes a new method in which the resistor is mounted in an enclosed cap on the side of the klystron socket tank, eliminating the above problem.

I. Introduction

The 400-kW DSN transmitter klystron requires a resistive path to ground for the modulating anode. The modulating anode being at ground potential via the resistive path causes the electrons leaving the cathode to be accelerated toward the anode. The physical construction of the cathode (Fig. 1) causes the electrons to converge into a very narrow beam as they pass through the modulating anode ring. When an arc occurs in the cathode region, the electrons intercept the modulating anode. The voltage generated across the resistors is a function of the electron current which is a function of the energy in the electron beam at the time of intercept. As the modulating anode's potential approaches that of the cathode, the electron emissions from the cathode will stop, and the arc will be suppressed. The resistive path has been provided in the past by two resistors in series mounted on the wall of the transmitter cabinet (Fig. 2). The volume of space required for the resistor in free air is in excess of 57,365 cm^3 (3,500 $in.^3$). The resistors were connected to the klystron socket tank by a short section of high-voltage cable and a high-voltage connector in the side of the klystron socket tank.

Two major problems exist with this method: (1) the high-voltage connector has a history of leaking the insulating oil in the socket tank, and (2) the resistors are exposed to mechanical damage. The new integral modulating anode resistor is mounted in a simple casing that is mounted with a reliable O-ring seal to the side of

the socket tank where the high-voltage connector was mounted for the external resistors. The integral modulating anode resistor uses only 1,033 cm^3 (63 $in.^3$) of space, part of which was used by the high-voltage connector. The unit is immersed in the high-voltage insulating oil which also cools the resistor. There is no high voltage present—no personnel hazard; there is a more reliable oil seal, and a protective seal cover over the resistor.

II. Description

The integral modulating resistor (Fig. 3) consists of a single 33-kΩ, 200-W resistor. The resistor is attached at one end to an insulating phenolic disk with a stud extending to the outside of the housing. This stud is then grounded to a second stud attached to the housing with a short jumper. This jumper can be used to monitor the current in the modulating anode for sensing internal arcing. The resistor extends beyond the housing and is insulated from the housing via a ceramic disk that has several openings so that the insulating oil can flow freely in and out of the housing. A contact clip is on the end of the resistor to make contact with modulating anode contact ring of the klystron. The oil which surrounds the resistor is water cooled so that the resistor can dissipate a very large amount of energy (heat) compared to the same resistor in free air. The dielectric strength of the oil is six times higher than that of air so that smaller space can be used for the same potential.

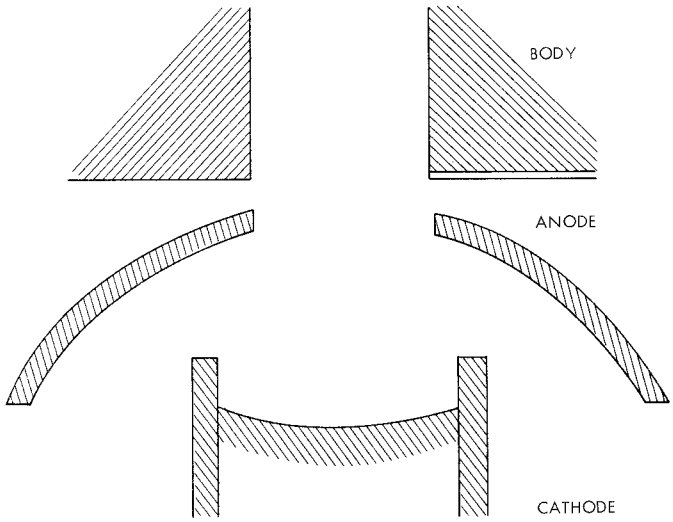

Fig. 1. Cathode-anode construction

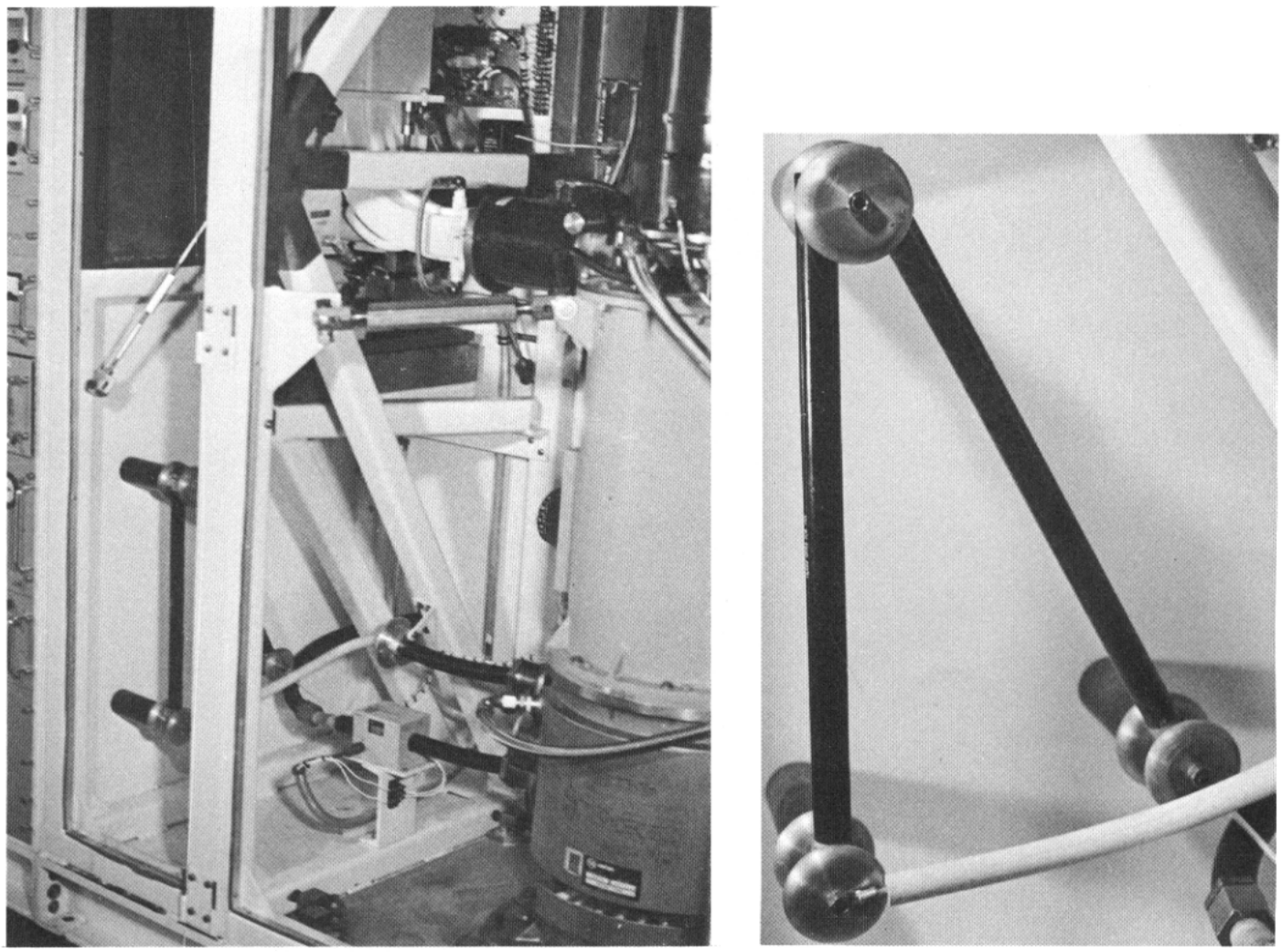

Fig. 2. Modulating anode resistor: (a) resistor mounted on wall (b) resistor and klystron connection

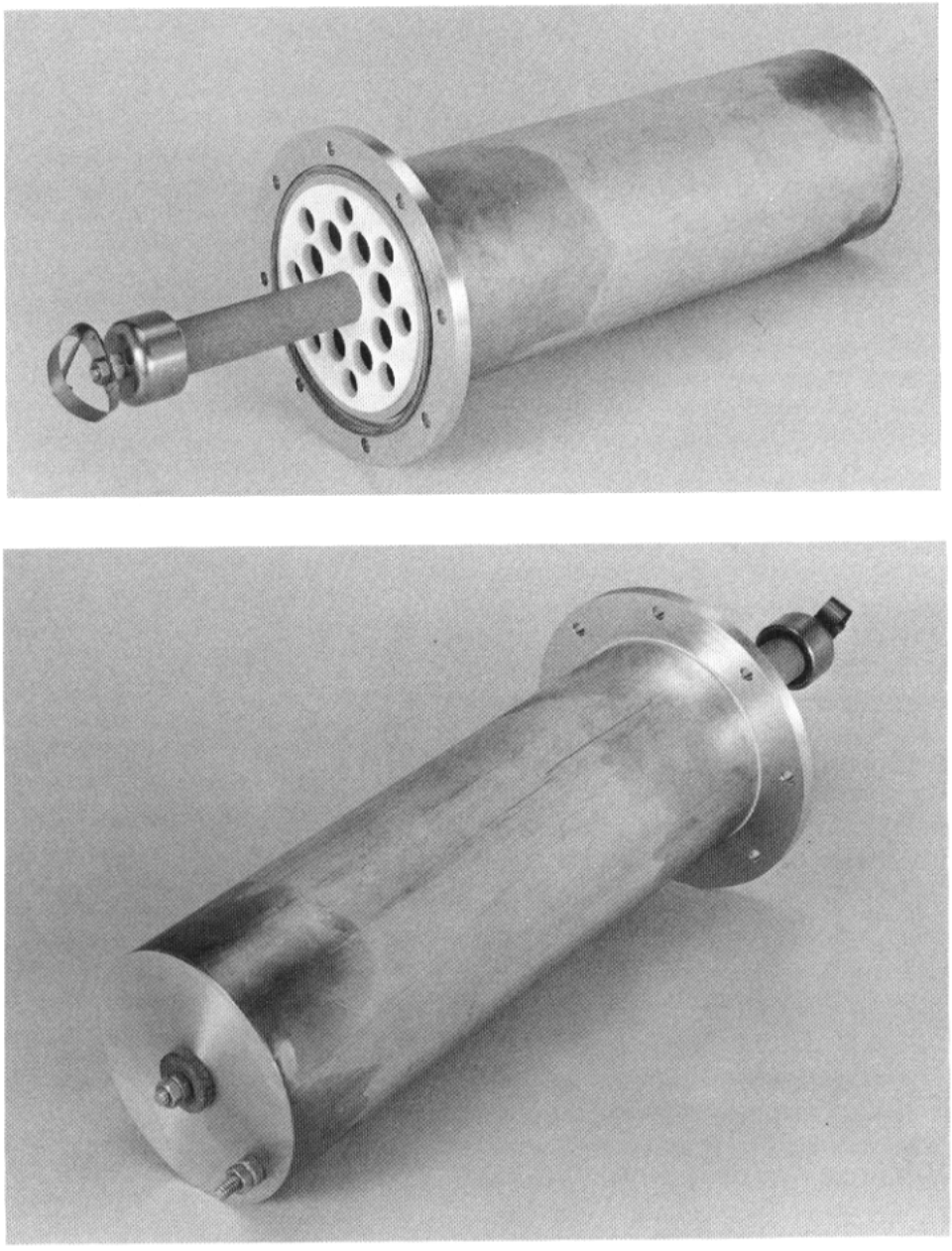

Fig. 3. Integral modulating anode resistor: (a) resistor end (b) grounding end